Environmental Sanitation as Risk Factors for Intestinal Protozoa Infection among Stunted Children in Sugerkidul Village, Indonesia

Hanu N. Septian[1], Erma Sulistyaningsih*[2], Angga M. Raharjo[3], Bagus Hermansyah[4], Wiwien S. Utami[5], Yunita Armiyanti[6]

[1, 2, 4, 5, 6] Department of Parasitology, University of Jember, Jember, Indonesia
[3] Department of Public Health, University of Jember, Jember, Indonesia

DOI: 10.24252/al-sihah.v15i1.35378
Received: 18 March 2023 / In Reviewed: 9 May 2023 / Accepted: 13 June 2023 / Available online: 29 June 2023

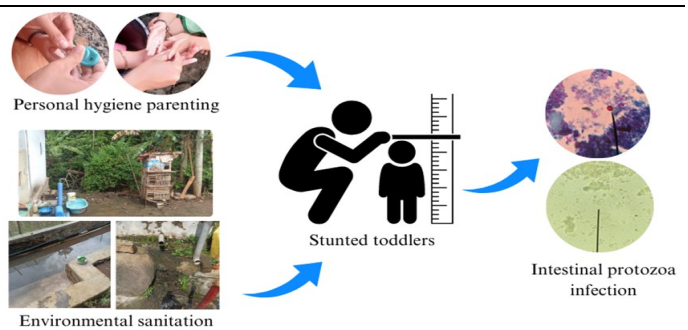
ABSTRACT

Stunting, a prevalent health issue in Indonesia, has been found to have a significant impact on the overall well-being of children, with a prevalence rate of 24.4%. This condition not only affects physical growth but also puts children at a heightened risk of various infections, including those caused by intestinal protozoa. Therefore, this study aimed to determine the relationship between personal hygiene parenting style and environmental sanitation with intestinal protozoa infection among stunted children in Sugerkidul Village, Jember District, Indonesia. The participants included were 30 stunted children. Questionnaires were used to collect data on personal hygiene parenting style and environmental sanitation, while microscopic stool examination was conducted to identify intestinal protozoa infection. The results showed that 26.7% of stunted children were infected with intestinal protozoa such as Giardia lamblia (13.3%), Blastocystis hominins (3.3%), and Cryptosporidium parvum (10%). Statistical analysis using Fisher's exact test showed a significant association between environmental sanitation and intestinal protozoa infection. However, there was no association between personal hygiene parenting style and this infection among stunted children in Sugerkidul Village. Therefore, to prevent intestinal protozoa infection, it is necessary to improve environmental sanitation.

ABSTRAK

Stunting merupakan masalah kesehatan yang penting di Indonesia, dengan prevalensi sebesar 24.4%. Gangguan ini mempengaruhi keseluruhan pertumbuhan dan perkembangan balita serta mengakibatkan risiko infeksi yang lebih tinggi, termasuk infeksi protozoa usus. Penelitian ini bertujuan untuk menganalisis hubungan antara pola asuh kebersihan diri dan sanitasi lingkungan dengan kejadian infeksi protozoa usus pada balita stunting di Desa Sugerkidul, Jember, Indonesia. Sebanyak 30 balita stunting dilibatkan dalam penelitian ini. Data pola asuh kebersihan diri dan sanitasi lingkungan dikumpulkan menggunakan kuesioner dan infeksi protozoa usus diidentifikasi dengan pemeriksaan mikroskopis feses. Infeksi protozoa usus ditemukan pada 26.7% balita stunting dan protozoa usus yang teridentifikasi antara lain Giardia lamblia (3.3%), Blastocystis hominis (3.3%), dan Cryptosporidium parvum (10%). Analisis statistik menggunakan Fischer exact test menunjukkan hubungan yang signifikan antara sanitasi lingkungan dengan kejadian infeksi protozoa usus, tetapi tidak signifikan pada hubungan antara pola asuh kebersihan diri dengan kejadian infeksi protozoa usus pada balita stunting di Desa Sugerkidul, Jember. Oleh karena itu, peningkatan sanitasi lingkungan sangat penting dalam upaya mencegah infeksi protozoa usus terutama pada balita stunting di wilayah ini.

GRAPHICAL ABSTRACT



Keyword
child
hygiene
intestinal diseases
protozoan infections
sanitation

*** Correspondence**
Jl. Mastrip No.69, Kec. Sumbersari, Kabupaten Jember, PO.Box 68124 Jawa Timur, Indonesia
Email: sulistyaningsih.fk@unej.ac.id

ISSN-P : 2086-2040
ISSN-E : 2548-5334

INTRODUCTION

Stunting, characterized by impaired growth and development in children, is a significant health problem observed in many developing countries, including Indonesia, where it is particularly prevalent. According to the Indonesia Nutritional Status Survey of the Ministry of Health, the incidence rate of this disorder in the country was 24.4% in 2021. Other developing countries, such as Pakistan, India, and Ethiopia reported rates of 31.7%, 35.5%, and 37%, respectively (Mengesha et al., 2021; Siddiqa et al., 2022; Varghese et al., 2022). East Java province was ranked 25th rank in terms of stunting prevalence in Indonesia in 2021, with a rate of 23.5%, and the district with the highest contribution was Jember, including SugerKidul village (Kementerian Kesehatan RI, 2021). Stunting is a complex health issue influenced by multiple factors, and infection is recognized as an important risk factor in its development (Akrom et al., 2022). Among various types of infections, gastrointestinal infection, including intestinal protozoa, are commonly reported (Fauziah et al., 2022). It is believed that these infections may contribute to stunting by causing nutrient malabsorption and direct nutrient loss in affected individuals (Rajoo et al., 2017).

The prevalence of intestinal protozoa infection remains high in Indonesia. A previous study reported that the incidence of this infection was rated at 20% (Wahdini et al., 2021), and is generally higher in children under 10 years old (Dobo, 2018). Children under 5 years had a rate of 36.8%, higher than those between 5 and 8 years, which was only 5.7% (Ntulume et al., 2017). The common protozoa that infect children under 5 years are *Entamoeba histolytica, Giardia lamblia*, *Cryptosporidium parvum,* and *Blastocystis hominis* (Boughattas et al., 2017; Tegen et al., 2020; Wale & Gedefaw, 2022).

Intestinal protozoa infection poses a risk to individuals, with children being particularly susceptible (Hajissa et al., 2022). This increased vulnerability among children can be attributed to their dynamic behavior, limited knowledge of hygiene practices, and the presence of intestinal protozoa contamination (Bahmani et al., 2017). The diseases usually occur due to unhygienic toilet practices and inadequate hand hygiene during eating times (Hajissa et al., 2022). Notably, children with poor hygiene practices have a higher likelihood of infection (Galgamuwa et al., 2016). s guardians, parents play a crucial role in ensuring their children's hygiene, thereby preventing such infections (Pérez Pico et al., 2022). The increase in risk of infection is attributed to poor hygiene practices of mothers (Wolde et al., 2022). Furthermore, environmental sanitation is associated with intestinal protozoa infection (Bahmani et al., 2017). Poor environmental sanitation due to feces contamination can increase risk of this disease (Wahdini et al., 2021). Additionally, protozoa can contaminate and spread through water, thereby causing infection (Hoseinzadeh et al., 2021).

Previous studies have demonstrated the determinants of personal hygiene, such as nail and hand hygiene (Mohammed et al., 2022). Environmental factors such as clean water facilities, latrine conditions, and waste management were associated with intestinal protozoa infection (Muhajir et al., 2019). Furthermore, studies showed the correlation between environmental sanitation and personal hygiene with intestinal protozoa infection in children (Balbino et al., 2023; Njambi et al., 2020; Tambunan & Panggabean, 2021). However, study on the parenting style aspect and environmental sanitation in stunted children remains limited. Therefore, this study analyzed personal hygiene's parenting style and environmental sanitation and their association with intestinal protozoa infection.

METHODS

This was an observational study with a cross-sectional design, conducted from August to December 2022. The participants were stunted children aged 12-59 months in Sugerkidul Village, Jember Regency, East Java Province, Indonesia. Informed consent was obtained from the mother of the children. The process involved a detailed explanation of the study's procedures and subsequently signing the approval. Finally, the participants in this study were 30 stunted children recruited by total sampling technique.

Data on personal hygiene parenting style including the cleanliness of nails and hands, as well as environmental sanitation, such as water facilities, toilet conditions, waste disposal, and garbage condition, were obtained by a questionnaire that was adapted from a previous study and consulted with experts (Kementerian Kesehatan RI, 2021; Tambunan & Panggabean, 2021). The validity and reliability of the questionnaire were determined using Pearson bivariate test and Cronbach's alpha value, respectively. Personal hygiene parenting style and environmental sanitation were scored and classified into 3 categories, namely good, moderate, and poor. Microscopic stool examination was conducted at the Laboratory of Parasitology, Faculty of Medicine, University of Jember. The stools were examined using the direct smear method to detect protozoa, including *Entamoeba histolytica, Giardia lamblia*, and *Blastocystis hominis*, while Ziehl Neelsen staining technique to detect *Cryptosporidium parvum*. The tools and materials utilized were centrifuge tube, vortex, glass slide, microscope, aqua dest solution, 1% Lugol solution, methanol, ZN A solution (Carbol fushin), ZN B solution (HCL and ethanol), and ZN C solution (Malachite green 0.4%).

Data were presented in frequency and percentage and the intervariable analysis was conducted using Fisher's exact test. Information on personal hygiene parenting style and environmental sanitation were recategorized into good and poor categories, which consisted of moderate and poor. The study was approved by the Ethical Committee of the Faculty of Medicine, University of Jember, with reference number 1668/H25.1.11/KE/2022.

RESULTS

The characteristics of respondents included gender and age of stunted children, education level, occupation of their mother, and family income. The majority were girls (56.7%) and aged between 24-35 months (46.7%). Most of their mothers were young, aged 20 to 25 (63.3%), have a low education level (76.7%), and are housewives (73.3%). Additionally, 83.3% have a low family income, as shown in table 1. The respondents at the proportion of 36.7% and 46.7% had a moderate personal hygiene parenting style and good as well as moderate environmental sanitation, respectively, as presented in table 1.

Microscopic stool examination showed that 8 respondents (26.7%) were positive for intestinal protozoa. The identified protozoa were *Giardia lamblia, Cryptosporidium parvum,* and *Blastocystis hominis, with G. lamblia* having the highest percentage of 13.3%. However, no *Entamoeba histolytica* was detected, as indicated in table 1.

The statistical analysis presented significant value and odds ratio. Personal hygiene parenting style has a significance value of 0.154, indicating that it is not significantly associated with intestinal protozoa infection. However, for environmental sanitation it was a 0.03 significance value, meaning there is a significant association. The odd ratio for personal hygiene parenting style and environmental sanitation were 4.846 and 10.111, respectively, as shown in table 2.

Table 1
Distribution of Characteristic of Respondents, Personal Hygiene and Environmental Sanitation

Characteristic of Respondent	Frequency	Percentage
Stunted Children Gender		
Male	17	56.67
Female	13	43.33
Stunted Children Age (month)		
12-33	6	20.00
24-35	14	46.67
36-47	7	23.33
48-59	3	10.00
Mother's Age (years)		
20-25	19	63.33
26-35	10	33.33
36-40	1	3.33
Mother's Education		
Low	23	76.67
High	7	23.33
Mother's Work Status		
Housewife	22	73.33
Working Mother	8	26.67
Family Income		
Low	25	83.33
Moderate	5	16.67
Personal Hygiene		
Good	10	33.33
Moderate	11	36.67
Poor	9	30.00
Environmental Sanitation		
Good	14	46.67
Moderate	14	46.67
Poor	2	6.67
Intestinal Protozoa Infection		
Positive	8	26.67
Negative	22	73.33
Protozoa Species*		
Entamoeba Histolytica	0	0.00
Giardia Lamblia	4	13.33
Cryptosporidium Parvum	3	10.00
Blastocytis Hominis	1	3.33

Note: *= There are 8 from 30 children diagnosed with intestinal protozoa infection.

DISCUSSION

Stunted children in this study were predominantly female and primarily between the age of 24 and 35 months of age when cognitive and motoric development occurs rapidly. This period needs high-quality and quantity nutrition, otherwise, they will be at an increased risk of stunting, and this is in line with previous studies (Manggala et al., 2018; Rajoo et al., 2017). Another interesting result is that mothers of children are between the age of 20 and 25 years, and this can be because of the high number of early marriages in Sugerkidul Village. Young mothers usually need to gain better knowledge and skills in caring for children. This is in accordance with their low education levels which makes it difficult to receive information on nutrition and child care, thereby increasing risk of raising stunted children. Despite most mothers being housewives who have more caring time, a low family income affects the ability to provide good food and nutrition, as reported by a previous study (Titaley et al., 2019).

Data on personal hygiene parenting

Table 2
Risk Factors for Intestinal Protozoa Infection

Variables	Intestinal Protozoa Infection				*Significance*	*Odds Ratio*
	Positive		Negative			
	Frequency	Percentage	Frequency	Percentage		
Personal Hygiene						
Good	1	12.5	9	40.9	0.150	4.85
Poor	7	87.5	13	59.1		
Environmental Sanitation						
Good	1	12.5	13	59.1	0.030*	10.11
Poor	7	87.5	9	40.9		

Note: *= Environmental sanitation has a significant relationship using the fisher's exact test (sig <0,05).

style showed variable results but slightly different between categories. Mothers ignore the children's hands and nail cleanliness habits, such as failing to ensure hand washing before eating, after defecating, and after playing. Some do not regularly cut their children's nails routinely every week, hence, they become dirty and unhygienic. This could be due to low education levels, which causes poor parenting styles (Muryanti et al., 2016). The majority of environmental sanitation in this study was good and moderate, and this is in line with the Jember health statistic in 2021. However, some participants have poor environmental sanitation, especially in the areas of waste disposal and garbage facilities.

Approximately 26.7% of respondents have intestinal protozoa infection. Children under the age of 5 have a higher risk of this disease, due to uncontrolled behavior (Tambunan & Panggabean, 2021; Zemene & Shiferaw, 2018). This study was conducted among stunted children, who are thought to be more susceptible to intestinal protozoa infection due to a lack of immune system, as reported in the previous study (Yoseph & Beyene, 2020). Furthermore, they have a high rate of infection due to a lack of immune systems (Akrom et al., 2022).

The most common type of intestinal protozoa in this study is *G. lamblia* which is high at 43% in low-income countries, and most often occurs in children (Waldram et al., 2017). According to the previous study, it is the most common infection in children under the age of 5 (Deka et al., 2022). *G. lamblia* infection usually occurs due to environmental sanitation conditions (Hajare et al., 2022). Other infection identified in this study were *Cryptosporidium parvum* and *B. hominis*. Previous studies stated that they can be identified among children under the age of 5 (Tamomh et al., 2021; Salehi Kahish et al., 2021). These opportunistic protozoa often attack humans with low immunity (Bednarska et al., 2018). However, no cases of *E. histolytica* were detected in the study.

According to a previous study, personal hygiene parenting style has no significant association with intestinal protozoa infection (Tsegaye et al., 2020). However, it was mostly identified among positively infected stunted children (Gizaw et al., 2018). Another study showed a significant association between personal hygiene and intestinal protozoa infection (Tambunan & Panggabean, 2021). Poor hygiene parenting has risk of contracting this disease. Furthermore, dirty nails and poor hand hygiene can raise risk of transmission (Berhe et al., 2020). Some indicators of personal hygiene parenting style, include hand and food hygiene which is essential among the caregivers of children under the age of 2 who cannot eat personally. A previous study showed that most mothers had poor hand hygiene behavior (El-Aal et

al., 2022). According to another study, the presence of dirty hands in mothers can lead to diarrhea in children, which could be caused by protozoa infection (Taddese et al., 2020). Food hygiene also plays a role in the existence of this disease, as unhygienic food serves as a suitable medium for protozoa cyst (Luz et al., 2017). The odds ratio value of 4.84 indicated that poor hygiene parenting can increase risk of infection by 4.85 times. Therefore, mothers should give more attention to children's hygiene to prevent intestinal protozoa infection.

In this study, environmental sanitation showed a significant association with intestinal protozoa infection (Yoseph & Beyene, 2020). The odd ratio also had a similar indication. The active behavior of children at home as well as around their environment has a higher potential for exposure to microorganisms, including protozoa. Notably, children who engage in play activities within unclean areas show a significant association with an increased risk of parasite infection (Eyasu et al., 2022). Some factors correlate with environmental sanitation and protozoa infection, such as protozoa contamination in water, food, or other objects. The quality of water plays a significant role in the relationship with this infection (Wale & Gedefaw, 2022). Furthermore, the distance between clean water and pollutant sources could be factors. This is because a minimum distance of 10 m is needed to decrease risk of contamination (Muhajir et al., 2019). Latrine conditions, wastewater disposal facilities, and the availability of trash cans are associated with the occurrence of this disease (Deka et al., 2022; Fuhrimann et al., 2016).

The study has shown that environmental sanitation is a vital factors in stunting (Gizaw et al., 2022), and it has a significant association with protozoa infection among stunted children. However, the study design which included only stunted children as participants, lead to a limited sample size. This result highlighted the importance of environmental sanitation on protozoa infection. Increasing public awareness regarding proper maintenance and improvement of environmental sanitation is pivotal in preventing health problems, including stunting as a growth disorder and microorganism infection such as intestinal protozoa.

CONCLUSIONS

This study found a high prevalence of protozoa infection, including *G. lamblia*, *B. hominis*, and *C. parvum*, among stunted children in Sugerkidul Village, Jember. Furthermore, environmental sanitation was observed to play a significant role in the occurrence of intestinal protozoa infection, while personal hygiene parenting style does not exhibit a direct association. However, it is important to note that poor personal hygiene parenting style carries a 4.84 times higher risk of this disease. Therefore, it is crucial for mothers or caregivers to enhance their awareness and adopt good personal hygiene parenting practices, along with maintaining proper environmental sanitation.

Despite the inclusion of all stunted children in Sugerkidul Village, Jember, it is important to acknowledge the limited sample size of this study. Furthermore, the study does not explore other potential risk factors for intestinal protozoa infection in children, such as food hygiene. Therefore, future research involving larger populations and considering various risk factors could provide valuable insights. The results of this study can serve as a reference for the government and other stakeholders in devising approaches to prevent intestinal protozoa infection and further reduce the prevalence of stunting. The significant association between environmental sanitation and intestinal protozoa infection in stunted children underscores its crucial role in designing comprehensive strategies to address health problems associated with stunting.

ACKNOWLEDGEMENT

The author would like thank to University of Jember for providing funding and support for this research. Our acknowledgment also conveyed to respondents who have agreed to be involved in the study.

FUNDING

This research was funded by University of Jember through the Grant of Research and Community Service Group No. 4484/UN25.3.1/LT/2022.

AUTHORS' CONTRIBUTIONS

Hanu N. Septian wrote the manuscript, collected data, analyzed the data, performed the field work. Erma Sulistyaningsih, wrote the manuscript, acquired and analyzed the data, reviewed and revised the manuscript. Angga M. Raharjo reviewed the manuscript. Bagus Hermansyah, Wiwien S. Utami, and Yunita Armiyanti revised the manuscript. All authors designed the study, formulated the concept and approved the final manuscript.

AUTHORS' INFORMATION

Dr. rer. bio. hum. dr. Erma Sulistyaningsih, M.Sc., GCert.AgHealthMed is an associate professor in Department of Parasitology Faculty of Medicine University of Jember, Jember, Indonesia. Angga Mardro Raharjo, MD, Pulmonologist Sp.P is an assistant professor in Department of Public Health Faculty of Medicine University of Jember, Jember, Indonesia. Bagus Hermansyah, MD., M.Biomed. is an assistant professor in Department of Parasitology Faculty of Medicine University of Jember, Jember, Indonesia. Dr. Wiwien Sugih Utami, MD., M.Sc. is an assistant professor in Department of Parasitology Faculty of Medicine University of Jember, Jember, Indonesia. Dr. Yunita Armiyanti, MD., M.Kes., Sp.Park. is an assistant professor in Department of Parasitology Faculty of Medicine University of Jember, Jember, Indonesia

COMPETING INTERESTS

The authors confirm that all of the text, figures, and tables in the submitted manuscript work are original work created by the authors and that there are no competing professional, financial, or personal interests from other parties.

REFERENCES

Akrom, A., Hidayati, T., Kencana, O. W., Kurniawan, N. U., & Bintarum, P. (2022). Infection and undernutrition increase the risk of stunting among rural children. *International Journal of Public Health Science*, *11*(3), 920–926. https://doi.org/10.11591/ijphs.v11i3.21592

Bahmani, P., Maleki, A., Sadeghi, S., Shahmoradi, B., & Ghahremani, E. (2017). Prevalence of intestinal protozoa infections and associated risk factors among schoolchildren in Sanandaj City, Iran. *Iranian Journal of Parasitology*, *12*(1), 108–116. https://pubmed.ncbi.nlm.nih.gov/28761467/

Balbino, L. F., Filho, A. A., Farias, B. E. S., Costa, G. V., Sinhorin, G. H., Silva, L. L. S., Marques, R. C. R., Jucá, F. L., Brilhante, A. F., & Melchior, L. A. K. (2023). Intestinal protozoan infections and environment conditions among rural schoolchildren in Western Brazilian Amazon. Brazilian Journal of Biology, 83, 1–4. https://doi.org/10.1590/1519-6984.247530

Bednarska, M., Jankowska, I., Pawelas, A., Piwczyńska, K., Bajer, A., Wolska-Kuśnierz, B., Wielopolska, M., & Welc-Falęciak, R. (2018). Prevalence of Cryptosporidium, Blastocystis, and other opportunistic infections in patients with primary and acquired immunodeficiency. Parasitology Research, 117(9), 2869–2879. https://doi.org/10.1007/s00436-018-5976-6

Berhe, B., Mardu, F., Tesfay, K., Legese, H., Adhanom, G., Haileslasie, H., Gebremichail, G., Tesfanchal, B., Shishay, N., & Negash, H. (2020). More than half prevalence of protozoan parasitic infections among diarrheic outpatients in eastern tigrai, ethiopia, 2019; a cross-sectional study. *Infection and Drug Resistance*, *13*, 27–34. https://doi.org/10.2147/IDR.S238493

Boughattas, S., Behnke, J. M., Al-Ansari, K., Sharma, A., Abu-Alainin, W., Al-Thani, A., & Abu-Madi, M. A. (2017). Molecular analysis of the enteric protozoa associated with acute diarrhea in hospitalized children. *Frontiers in Cellular and Infection Microbiology*, *7*(343), 1–10. https://doi.org/10.3389/fcimb.2017.00343

Deka, S., Kalita, D., & Hazarika, N. K. (2022). Prevalence and Risk Factors of Intestinal Parasitic Infection in Under□Five Children With Malnutrition: A Hospital Based Cross□Sectional Study. *Journal of Family Medicine and Primary Care*, *11*(6), 2794–2801. https://doi.org/10.4103/jfmpc.jfmpc_1742_21

Dobo, B. (2018). Prevalence of intestinal protozoan infection among patients in Hawassa city administration millennium health center, Ethiopia. *Journal of Applied Biotechnology & Bioengineering*, *5*(4), 206–210. https://doi.org/10.15406/jabb.2018.05.00139

El-Aal, B. G. A., Nady, S. E., Shokr, E. A., & Shokry, M. W. (2022). Awareness And Practices Of Preventive Behaviors Toward Intestinal Parasitic Infection Among Mothers Of Preschool Children. *Journal of Positive School Psychology*, *6*(8), 6290–6305. https://journalppw.com/index.php/jpsp/article/view/10926

Eyasu, A., Molla, M., Kefale, B., Sisay, W., Andargie, Y., Kebede, F., & Jemere, T. (2022). Prevalence and Associated Risk Factors of Endoparasites among Under-Five Children in Debre Tabor Comprehensive Specialized Hospital, Debre Tabor, Northwest Ethiopia: A Cross-Sectional Study. *Journal of Parasitology Research*, *2022*, 1–10. https://doi.org/10.1155/2022/6917355

Fauziah, N., Aviani, J. K., Agrianfanny, Y. N., & Fatimah, S. N. (2022). Intestinal Parasitic Infection and Nutritional Status in Children under Five Years Old: A Systematic Review. *Tropical Medicine and Infectious Disease*, *7*(11), 371. https://doi.org/10.3390/tropicalmed7110371

Fuhrimann, S., Winkler, M. S., Pham-Duc, P., Do-Trung, D., Schindler, C., Utzinger, J., & Cissé, G. (2016). Intestinal parasite infections and associated risk factors in communities exposed to wastewater in urban and peri-urban transition zones in Hanoi, Vietnam. *Parasites and Vectors*, *9*(1), 1–14. https://doi.org/10.1186/s13071-016-1809-6

Galgamuwa, L., Iddawela, D., & Dharmaratne, S. (2016). Intestinal protozoa infections, associated risk factors and clinical features among children in a low-income tea plantation community in Sri Lanka. *International Journal of Community Medicine and Public Health*, *3*(9), 2452–2458. https://doi.org/10.18203/2394-6040.ijcmph20163053

Gizaw, Z., Adane, T., Azanaw, J., Addisu, A., & Haile, D. (2018). Childhood intestinal parasitic infection and sanitation predictors in rural Dembiya, northwest Ethiopia. *Environmental Health and Preventive Medicine*, *23*(1),

1–10. https://doi.org/10.1186/s12199-018-0714-3

Gizaw, Z., Yalew, A. W., Bitew, B. D., Lee, J., & Bisesi, M. (2022). Stunting among children aged 24–59 months and associations with sanitation, enteric infections, and environmental enteric dysfunction in rural northwest Ethiopia. *Scientific Reports*, *12*(1), 1–11. https://doi.org/10.1038/s41598-022-23981-5

Hajare, S. T., Chekol, Y., & Chauhan, N. M. (2022). Assessment of prevalence of Giardia lamblia infection and its associated factors among government elementary school children from Sidama zone, SNNPR, Ethiopia. *PLoS ONE*, *17*(3), 1–17. https://doi.org/10.1371/journal.pone.0264812

Hajissa, K., Islam, M. A., Sanyang, A. M., & Mohamed, Z. (2022). Prevalence of intestinal protozoan parasites among school children in africa: A systematic review and meta-analysis. *PLoS Neglected Tropical Diseases*, *16*(2), 1–20. https://doi.org/10.1371/journal.pntd.0009971

Hoseinzadeh, E., Rostamian, A., Razaghi, M., & Wei, C. (2021). Waterborne transmission of protozoan parasites: A review of water resources in Iran – An update 2020. *Desalination and Water Treatment*, *213*, 91–105. https://doi.org/10.5004/dwt.2021.26678

Kementerian Kesehatan RI. (2021). *Laporan Kinerja Kementerian Kesehatan 2021*. Kementerian Kesehatan Republik Indonesia. http://ppid.kemkes.go.id/uploads/img_62f0d4c9e9f34.pdf

Luz, J. G. G., de Carvalho, A. G., Marques, A. P., Marcondes, A. A., Roma, J. H. F., Castro, L. S., Castro, L. S., Dias, J. V. L., & Pavoni, J. H. C. (2017). Intestinal parasitic infections and associated risk factors in preschoolers from different urban settings in Central-Western Brazil. *Asian Pacific Journal of Tropical Disease*, *7*(7), 405–410. https://doi.org/10.12980/apjtd.7.2017D7-90

Manggala, A. K., Wiswa, K., Kenwa, M., Me, M., Kenwa, L., Agung, A., Dwinaldo, G., Jaya, P., Agung, A., & Sawitri, S. (2018). Risk factors of stunting in children aged 24-59 months Arya. *Paediatrica Indonesiana*, *58*(5), 205–212. http://dx.doi.org/10.14238/pi58.5.2018.205-12

Mengesha, A., Hailu, S., Birhane, M., & Belay, M. M. (2021). The Prevalence of Stunting and Associated Factors among Children Under Five years of age in Southern Ethiopia : Community Based Cross-Sectional Study. 87(1), 1–14. https://doi.org/10.5334/aogh.3432

Mohammed, J., Shiferaw, A., Zeleke, A., Eshetu, Y., Gebeyehu, Z., Ayehu, A., & Adem, Y. (2022). Prevalence and Associated Risk Factors of Intestinal Parasites among Diarrheic Under-Five Children Attending Bahir Dar and Han Health Centers, Northwest Ethiopia: A Cross-Sectional Study. *Journal of Parasitology Research*, *2022*(1), 1–9. https://doi.org/10.1155/2022/7066529

Muhajir, N. F., Herdiana, E., & Mulyaningsih, B. (2019). Study of intestinal protozoa infectio in the hospitalized patients diagnosed with diarrhoea in the Panembahan Senopati hospital. *Jurnal Kedokteran Dan Kesehatan Indonesia*, *10*(2), 176–184. https://doi.org/10.20885/jkki.vol10.iss2.art10

Muryanti, Dharmawan, R., & Murti, B. (2016). The Relationship Between Maternal Education, Family Income, Parenting Style, and Language Development in Children Aged 3-4 Years in Boyolali, Central Java. *Indonesian Journal of Medicine*, *1*(2), 100–107. https://doi.org/10.26911/theijmed.2016.01.02.03

Njambi, E., Magu, D., Masaku, J., Okoyo, C., & Njenga, S. M. (2020). Prevalence of Intestinal Parasitic Infections and Associated Water, Sanitation, and Hygiene Risk Factors among School Children in Mwea Irrigation Scheme, Kirinyaga County, Kenya. Journal of Tropical Medicine, 2020(1), 1–9. https://doi.org/10.1155/2020/3974156

Ntulume, I., Tibyangye, J., Aliero, A., & Banson, B. (2017). Prevalence of Intestinal Protozoan Infections and the Associated Risk Factors among Children in Bushenyi District, Western Uganda. *International Journal of Tropical Disease & Health*, *23*(2), 1–9. https://doi.org/10.9734/ijtdh/2017/33255

Pérez Pico, A. M., Álvarez, E. M., Rodríguez, J. V., & Acevedo, R. M. (2022). Differences in Hygiene Habits among Children Aged 8 to 11 Years by Type of Schooling. *Children*, *9*(2), 1–16. https://doi.org/10.3390/children9020129

Rajoo, Y., Ambu, S., Lim, Y. A. L., Rajoo, K., Tey, S. C., Lu, C. W., & Ngui, R. (2017). Neglected intestinal parasites, malnutrition and associated key factors: A population based cross-sectional study among indigenous communities in sarawak, Malaysia. *PLoS ONE*, *12*(1), 1–17. https://doi.org/10.1371/journal.pone.0170174

Salehi Kahish, R., Alghasi, A., Hadadi, S., Nasab, M. A., & Mafakherzadeh, A. (2021). The prevalence of blastocystis infection in pediatric patients with malignancy: A single-center study in Ahvaz, Iran. *Archives of Pediatric Infectious Diseases*, *9*(2), 1–5. https://doi.org/10.5812/pedinfect.104068

Siddiqa, M., Zubair, A., Kamal, A., Ijaz, M., & Abushal, T. (2022). Prevalence and associated factors of stunting , wasting and underweight of children below five using quintile regression analysis (PDHS 2017 – 2018). Scientific Reports, 1–8. https://doi.org/10.1038/s41598-022-24063-2

Taddese, A. A., Dagnew, B., Dagne, H., & Andualem, Z. (2020). Mother's Handwashing Practices and Health Outcomes of Under-Five Children in Northwest Ethiopia. *Pediatric Health, Medicine and Therapeutics*, *11*(1), 101–108. https://doi.org/10.2147/phmt.s238392

Tambunan, Y. R., & Panggabean, Y. C. (2021). The Correlation between Personal Hygiene and Intestinal Parasitic Infection in Students of SDN 060889, SDN 060894, and SDN 060831 Medan. *Journal of Endocrinology, Tropical Medicine, and Infectious Disease (JETROMI)*, *3*(3), 78–84. https://doi.org/10.32734/jetromi.v3i3.3550

Tamomh, A. G., Agena, A. E. M., Elamin, E., Suliman, M. A., Elmadani, M., Omara, A. B., & Musa, S. A. (2021). Prevalence of cryptosporidiosis among children with diarrhoea under five years admitted to Kosti teaching hospital, Kosti City, Sudan. *BMC Infectious Diseases*, *21*(1), 1–6. https://doi.org/10.1186/s12879-021-06047-1

Tegen, D., Damtie, D., & Hailegebriel, T. (2020). Prevalence and Associated Risk Factors of Human Intestinal Protozoan Parasitic Infections in Ethiopia: A Systematic Review and Meta-Analysis. *Journal of Parasitology Research*, *2020*(1), 1–15. https://doi.org/10.1155/2020/8884064

Titaley, C. R., Ariawan, I., Hapsari, D., Muasyaroh, A., & Dibley, M. J. (2019). Determinants of the stunting of children under two years old in Indonesia: A multilevel analysis of the 2013 Indonesia basic health survey. *Nutrients*, *11*(5), 1–13. https://doi.org/10.3390/nu11051106

Tsegaye, B., Yoseph, A., & Beyene, H. (2020). Prevalence and factors associated with intestinal parasites among children of age 6 to 59 months in, Boricha district, South Ethiopia, in 2018. BMC Pediatrics, 20(1), 28. https://doi.org/10.1186/s12887-020-1935-3

Varghese, J. S., Gupta, A., Mehta, R., Stein, A. D., & Patel, S. A. (2022). Changes in Child Undernutrition and Overweight

in India From 2006 to 2021: An Ecological Analysis of 36 States. Global Health: Science and Practice, 10(5), 1–10. https://doi.org/10.9745/GHSP-D-21-00569

Wahdini, S., Putra, V. P., & Sungkar, S. (2021). The prevalence of intestinal protozoan infections among children in southwest sumba based on the type of water sources. *Infection and Chemotherapy*, *53*(3), 519–527. https://doi.org/10.3947/ic.2021.0067

Waldram, A., Vivancos, R., Hartley, C., & Lamden, K. (2017). Prevalence of Giardia infection in households of Giardia cases and risk factors for household transmission. *BMC Infectious Diseases*, *17*(1), 1–7. https://doi.org/10.1186/s12879-017-2586-3

Wale, M., & Gedefaw, S. (2022). Prevalence of Intestinal Protozoa and Soil Transmitted Helminths Infections among School Children in Jaragedo Town, South Gondar Zone of Ethiopia. *Journal of Tropical Medicine*, *2022*(1), 1–11. https://doi.org/10.1155/2022/5747978

Wolde, M., Abate, M., Mandefro, G., Beru, E., Kassahun, A., & Tesema, G. A. (2022). Determinants of handwashing practice and its associated factors among mothers of under-5 children in Kolladiba town, Northwest Ethiopia: Cross-sectional study. *BMJ Open*, *12*(6). https://doi.org/10.1136/bmjopen-2021-058960

Yoseph, A., & Beyene, H. (2020). The high prevalence of intestinal parasitic infections is associated with stunting among children aged 6-59 months in Boricha Woreda, Southern Ethiopia: A cross-sectional study. *BMC Public Health*, *20*(1), 1–13. https://doi.org/10.1186/s12889-020-09377-y

Zemene, T., & Shiferaw, M. B. (2018). Prevalence of intestinal parasitic infections in children under the age of 5 years attending the Debre Birhan referral hospital, North Shoa, Ethiopia. *BMC Research Notes*, *11*(1), 1–6. https://doi.org/10.1186/s13104-018-3166-3.